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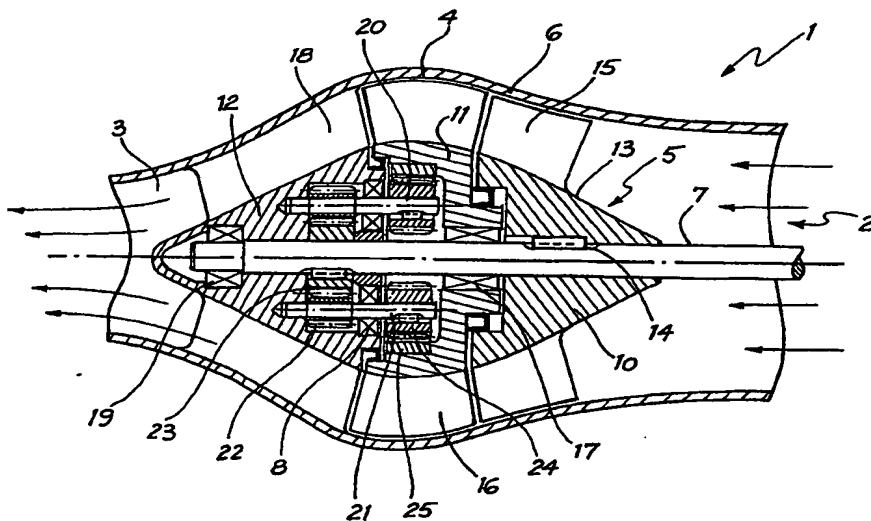
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/AU98/00460 (22) International Filing Date: 12 June 1998 (12.06.98) (30) Priority Data: PO 7353 13 June 1997 (13.06.97) AU (71) Applicants (for all designated States except US): HEADLAND SECURITIES PTY. LTD. [AU/AU]; 56 Headland Road, Castle Cove, NSW 2069 (AU). CAMERON, Ron [AU/AU]; 9 Court Road, Double Bay, NSW 2028 (AU). (72) Inventor; and (75) Inventor/Applicant (for US only): GILLIES, Donald, Alexander [AU/AU]; 3/3 Brunton Place,, Marsfield, NSW 2122 (AU). (74) Agent: RANTZEN, Henry, John; 85 John Street, Woollahra, NSW 2025 (AU).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>

(54) Title: CONTRA-ROTATING DUCTED IMPELLERS**(57) Abstract**

A marine ducted impeller drive assembly (1) has a water inlet end (2) and a water outlet end (3) in an annulus between which are located two sets (15, 16) of impeller blades. The sets are rotated in respectively opposite directions by a single drive shaft (7) which is connected directly to rotate one blade set (15) in one direction, and is connected indirectly to drive the other blade set (16) in the reverse direction. Contra-rotation of the blade sets (15, 16) is achieved by gearing provided by double-ended pinions (21) driven from the shaft (7) through an external gear (23, 22) and driving the set of blades (16) through an internal gear (24, 25). Flow-straightening blades (18) straighten out whirling motion of the water discharged from the assembly and support a downstream part of the inner wall of the annulus.

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CONTRA-ROTATING DUCTED IMPELLERS

FIELD OF THE INVENTION

THIS INVENTION relates to assemblies in which coaxial sets of impeller blades are mounted for rotation in an annular passage and a fluid, such as water, is caused to flow through the passage between an inlet and outlet. Such an assembly will hereinafter be referred to as being "of the type described". Such an assembly may take the form of a gas or water pump or a turbine. More specifically, although not exclusively, the invention is concerned with a propulsion system for use in ships and of the water jet type. As this represents the dominant use of the invention as at present conceived, the remainder of this specification will concern itself with describing the use of an assembly of the type described, in a water jet propulsion system of a marine vessel. However it is to be understood that the principle of the invention may be usefully employed in other fields where it is required to transfer energy between a moving stream of a gaseous or liquid fluid, and a rotating shaft.

STATE OF THE ART

- 15 Water jet propulsion systems are often used on vessels required to operate in conditions in which the use of an external propeller poses difficulties. Currently water jet propulsion systems are commonly encountered in connection with high-speed ferries, multi-hull vessels such as catamarans, and small vessels required to operate in very shallow water or in close proximity to bathers.
- 20 The conventional water jet propulsion system uses an impeller rotated in a section of a duct which extends from a water entry, usually located beneath the vessel and covered with a protective grid, and a water outlet through which a jet of water is discharged at high speed to drive the vessel forwards. All the parts of the propulsion system are accessible from within the hull of the vessel and above the water-line, which makes repair to the impeller rather easier than when an external marine propeller is used. The modern tendency in ship-building is towards light-weight, high-speed vessels with shallow draft and this favours the use of water-jet propulsion rather than the conventional propeller system.

OBJECT OF THE INVENTION

An object of this invention is to provide an improved assembly of the type described.

30 THE INVENTION

In accordance with a first aspect of the invention, an assembly of the type described has two sets of impeller blades coaxially arranged on a common shaft which is rigidly connected to one of the sets to rotate therewith, and has the other set of blades connected to the shaft by

way of a reversing drive which has at least one double-ended pinion arranged axially parallel to the shaft and meshing at one geared end with a geared surface rotated by the shaft, and meshing at the other end with a geared surface provided on said other set of blades, reversal of the two sets of blades being achieved by arranging for the two geared surfaces to form
5 parts of an internal gear system and an external gear system, respectively.

In accordance with a second aspect of the invention a drive assembly for a water jet propulsion system provides a water duct section of annular form defined between two walls one of which is formed in three axially-spaced parts of which one part is held against rotation, a second part is attached to a drive shaft extending coaxially through the duct section and carries a
10 first set of impeller blades for driving water through the duct section when the shaft is rotated, and a third part carrying a second set of impeller blades which is rotated in the opposite direction to the first set by a reversing gear mounted on the first part and transmitting drive from the drive shaft to the second part.

ADVANTAGES AND PREFERRED FEATURES OF THE INVENTION

15 An advantage of the second aspect of the invention is that it enables the momentum of the discharging water jet from the vessel to be increased, with a consequential increase in the vessel's performance.

Preferably the reversing gear comprises one or more double-ended gear pinions which mesh at one end-portion with a geared surface on the drive shaft, and at the other end-portion with
20 a geared surface on the second part. To obtain a reversal of the drive direction to the second part, the meshing gears at the two end-portions of the pinion are respectively arranged as an external gear and as an internal gear (commonly known as a ring gear).

INTRODUCTION TO THE DRAWING

The invention will now be described in more detail, by way of example, with reference to the
25 accompanying drawing which shows in diagrammatic form a vertical section through a duct section of a water jet propulsion assembly.

DESCRIPTION OF PREFERRED EMBODIMENT

A vessel to which the water jet propulsion assembly is fitted, is not illustrated or described, as such vessels are now well-known in the art.

The assembly 1 has its right-hand end 2 connected to receive water from submerged water inlet (not shown) located beneath the vessel in which the assembly is mounted, and its left-hand end 3 connected to a jet nozzle (not shown) at the stern of the vessel and from which a high velocity jet of water is discharged to propel the vessel forwards.

- 5 The assembly 1 provides an annular duct 4 formed between a boss 5 and an outer wall 6. A drive shaft 7 of a marine engine (not shown) extends coaxially through the duct 4.

The boss 5 has three coaxially spaced parts 10, 11 and 12 and its outside surface provides the inside wall 13 of the duct 4.

- 10 The upstream part 10 of the boss 5 is keyed at 14 to the shaft 7 to rotate therewith, and carries a set of impeller blades 15 which rotate in the annular duct 4 when the shaft 7 is rotated. The intermediate part 11 of the boss 5 also carries a set of impeller blades 16 and is supported by a bearing 17 on the shaft 7. The downstream part 12 of the boss 5 is fixed to the outer wall of the duct by a set of flow-straightening vanes 18 which straighten out the 15 whirling motion of the water leaving the second set of impeller blades 16. Bearings 19 support the tail end of the shaft 7.

A reversing gear 20 drives the second part 11 of the boss 5 in the opposite direction to the shaft 7 and is provided by one or more double-ended pinions 21 preferably symmetrically arranged around the shaft 7 and having their individual axes parallel thereto. The reversing 20 gear 20 is supported by bearings 8 in the downstream part 12 of the boss 5 and has at one end a pinion gear 22 which meshes with an externally geared surface 23 on the shaft 7, and at the other end a second pinion gear 24 which meshes with an internal geared surface 25 provided on the second part 11 of the boss 5.

OPERATION OF THE PREFERRED EMBODIMENT

- 25 During operation of the assembly, the rotational drive of the shaft 7 rotates the first set of impeller blades 15 in the same direction as the shaft. The second set of impeller blades 16 is driven in the opposite direction to the first set, through the action of the internal and external gearing provided respectively at opposite ends of the double-ended pinions 21.

ADVANTAGES OF PREFERRED EMBODIMENT

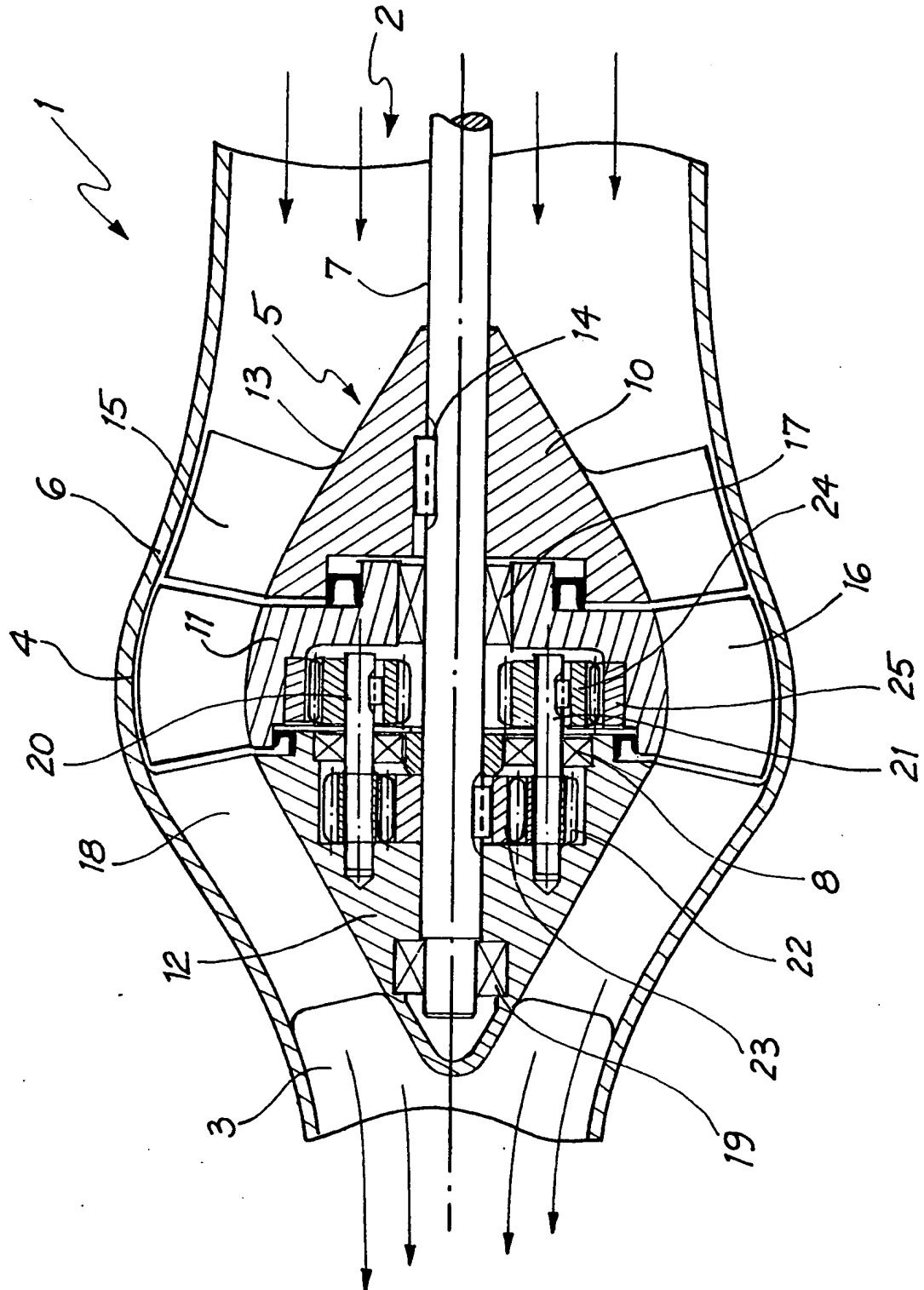
The above-described assembly is simple to construct and straight forward in its operation. It has the advantage that the improvement in efficiency obtained by using contra-rotating sets of impellers is achieved from a single drive shaft. Existing water jet propulsion systems can thus be modified to utilise the invention without having to provide each set of

5 impellers with its own drive shaft.

CLAIMS

1. An assembly of the type described in the opening paragraph of the accompanying specification, having two sets of impeller blades coaxially arranged on a common shaft which is rigidly connected to one of the sets to rotate therewith, and has the other set of blades
5 connected to the shaft by way of a reversing drive which has at least one double-ended pinion arranged axially parallel to the shaft and meshing at one geared end with a geared surface rotated by the shaft, and meshing at the other end with a geared surface provided on the said other set of blades, reversal of the two sets of blades being achieved by arranging for the two geared surfaces to form parts of an internal gear system and an external gear system,
10 respectively.
2. A drive assembly for a water jet propulsion system providing a water duct section of annular form defined between two walls one of which is formed in three axially-spaced parts of which one part is held against rotation, a second part is attached to a drive shaft extending coaxially through the duct section and carries a first set of impeller blades for driving water
15 through the duct section when the shaft is rotated, and a third part carrying a second set of impeller blades which is rotated in the opposite direction to the first set by a reversing gear mounted on the first part and transmitting drive from the drive shaft to the second part.
3. A drive assembly as set forth in claim 2, in which the reversing gear comprises ~~one or~~ more double-ended gear pinions which each mesh at one end-portion with an externally
20 geared surface on the drive shaft, and at the other end-portion with an internally geared surface on said second part.

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INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 98/00460

A. CLASSIFICATION OF SUBJECT MATTER		
Int Cl ⁶ : B63H 5/10, 11/08, B64C 11/48, F01D 1/26		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) IPC : B63H 5/10, B63H 11/08, B64C 11/48, F01D 1/26		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPAT		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96/09954 A1 (CAMERON et al) 4 April 1996 Abstract, page 1 paragraph 1 and figs. 2-3	1-3
E,X	WO 98/29300 A1 (HEADLAND SECURITIES PTY LTD et al) 9 July 1998 Abstract	1-3
X	US 3269111 A (BRILL) 30 August 1966 Column 2, lines 3-67 and fig. 1	2
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
<p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>		
Date of the actual completion of the international search 13 August 1998		Date of mailing of the international search report 19 AUG 1998
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (02) 6285 3929		Authorized officer S.J. DESCHANEL Telephone No.: (02) 6283 2368

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/AU 98/00460

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2240591A (MTU MOTOREN-UND TURBINEN UNION) 7 August 1991	1

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 98/00460**Box I** Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claim 1 directed to an assembly of two coaxial, counter-rotating sets of impellers, the counter-rotation being achieved by means of a reversing drive including one double-ended pinion.
2. Claim 2 directed to a water jet propulsion system including a first set of impeller blades and a second set of impeller blades driven in the opposite direction by a reversing gear.
1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

Information on patent family members

PCT/AU 98/00460

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
WO	96/09954	AU	35975/95	CA	2201146	EP	783430
		NO	971249				
GB	2240591	DE	3941852	FR	2657121	US	5137425